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SCIENCE

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THE VALUE OF ZOOLOGY TO HUMANITY¹ THE CULTURAL VALUE OF ZOOLOGY

ALL sciences are so interrelated that it is not easy to point out the distinctive contributions of any one science to human welfare, and in particular I have found it impossible to separate zoology from other biological sciences in this regard. Accordingly, in what I shall say it will be understood that I am speaking for all the biological sciences and not for zoology alone.

Again culture is no single definite object, but a general and rather indefinite ideal. There are many kinds of culture—physical, intellectual, moral, esthetic, religious, governmental, etc.—but each and all forms of culture may be regarded from the standpoint of the individual or from that of society; the former we call education, the latter civilization.

I. CONTRIBUTIONS OF BIOLOGY TO EDUCATION

The method of the scientist is to generalize only from particular objects or phenomena, and a naturalist, if asked what the cultural value of biology is, would ask to see some of the specimens. The members of this society are my specimens, my living exhibits of the cultural value of biology. What are your distinctive cultural characteristics? To avoid the personal error it would have been well to have asked each one of you to describe the characteristics of some other member of the society, but making allowance for the personal error, I believe that the biologist shows the following qualities:

1. Immense enthusiasm and intense con-

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¹ Four papers in a symposium before the American Society of Naturalists, Philadelphia, December 31, 1914.

centration in his work. He desires no vacations except for bug-hunting and collecting. His idea of a good time is to have a day off for work with his microscope. He is a biologist because the tendency within him is too strong to be resisted. He feels that he was born for one work only. In a peculiar sense he has had the baptism of science—he has “renounced the Devil and all his works, the vain pomp and glory of the world,” and has devoted himself with singleness of purpose to one particular subject which seems to him the central theme from which all others radiate.

But this very enthusiasm and concentration has its dangers for it is liable to destroy the sense of perspective and proportion. President Lowell has several times referred to a university course, whether real or mythological he does not say, on the “*Antennæ of the Paleozoic Cockroach*”—a highly specialized course, it must be admitted, and yet probably no more so than many others to be found in our universities. Our opinions regarding the value of any subject are greatly influenced by our knowledge or ignorance of that subject. There are persons who laugh at all foreigners; they think “they are so funny.” There can be no doubt that specialization on any subject which is out of the ordinary seems funny to those who think only conventional thoughts. A great biologist was once at a public reception where he looked and doubtless felt much out of place. A society woman tried to engage him in small talk, but he replied, “Madam, the Maryland oyster is being exterminated.” The original “Professor Mooner” of the comic papers was probably an old-fashioned naturalist. Intense devotion to work is a fine thing and has cultural value if properly balanced by a true sense of proportion, but the effect is otherwise if this concentration blots out for one the rest of the universe.

The evil effects of over-specialization are shown in many ways among biologists—not only in the lack of ability to understand or appreciate many other lines of work, but also by the very prevalent notion that the biologist who engages in economic work or who devotes himself to public service has somehow lost caste, and also by the contrasting opinion held by some “practical” biologists that “academic biology should be classed with embroidery.” There are many good biologists in economic work, but there are relatively few in public life, and it is a pity that it is so, for on many biological problems of the highest interest to society the biologist could speak with an authority at least as great as that of the sociologists, who are frequently more sure of our results than we are ourselves, an authority greater than that of the propagandists who invent their own biology. On the other hand, there are a few great leaders in biology who have become teachers and interpreters to the plain people, men who like Huxley, Galton, Metchnikoff and Forel have dared to apply the teachings of biology to social problems, and there are more biologists who would do this if they were not restrained by the fear of losing caste among extreme specialists.

But, after all, concentration and narrowness are by no means characteristic of biologists and are probably to be ascribed to the weakness of human nature rather than to the influences of biology.

2. A second quality which is more truly distinctive of the biologist is to be found in his powers of observation and imagination. Other sciences also train both of these faculties, but in a peculiar sense the living world is an eternal challenge and stimulus to the powers of observation and constructive imagination.

No one can have failed to notice the great interest which all persons show in living objects. Men, women and children will

watch without weariness the movements of living things when they could not be induced to study the pictures of them in a book. Even many of the higher animals show great interest in and curiosity about moving objects which would remain unnoticed if perfectly still. Is not the source of this universal interest in living things to be found in the fact that we recognize in them fellow creatures with feelings akin to our own? Is not the great craze for moving pictures due to the fact that the movements make the pictures live?

Instinctively we recognize the kinship of all living things; instinctively we attribute to them the joy and sorrow, the fear and courage, the love and hate which we also experience; instinctively our curiosity is aroused and our observation and imagination are stimulated. And when we are older grown and have learned more about the "mechanism of life" do we not find that our curiosity, admiration and wonder are increased rather than diminished? Does not the great mystery of life appeal to the biologist even more than to others? I am sure that I represent the experience of every biologist when I say that the living world is a powerful and unfailing stimulus to the faculties of observation and imagination.

3. Biology occupies a unique place among all the sciences in its cultivation of esthetic appreciation and broad sympathies. It was for this reason that the late Professor Blackie said that he would have all young persons taught music and natural history. The naturalist is an artist in spirit if not in technique. It is sometimes a question how to classify the great artist-naturalists of the past such as Leonardo, Chamisso, Goethe and Audubon, and even if in these days of greater specialization the technique of art and of science are rarely combined in the same person the

spirit of the two is combined in every naturalist worthy of the name and not infrequently strives to express itself in the figures and plates with which he adorns his scientific papers.

The biologist is thrilled by the beauty, the fitness, the mystery of organisms, and no scientific explanations of this beauty, fitness and mystery can destroy the esthetic appreciation which they cultivate. In the anatomical study of dead bodies there is less of this esthetic sense than in the study of living, moving, sentient beings, and yet was it not Johannes Müller who said "The anatomist should have the eye of an angel, the hand of an artist and the stomach of a pig"?

With this esthetic appreciation of nature there is mixed a broad sympathy with all living things. We can appreciate the feelings of that student who said that before he studied biology he used to try to crush the earthworms on the walks, but now that he had learned something about their marvelous structures and habits he carefully avoided stepping on them. Every ornithologist can appreciate the feeling of St. Francis of Assisi who called the birds his brothers. In this building which is a monument to his ability and energy I can not forget the naturalist Montgomery, who remembered to his dying day "the thrill with which he first heard the song of the blue bird" and who rejoiced that he was a part of immortal nature.

The biologist has his eyes open to the beauties, the joys, the sufferings of living things. What an outrage it is that he is so often pictured as a cruel and bloody monster! His sympathies extend not merely to his humbler brothers, but his human sympathies are broadened and deepened. The real naturalist can not look upon the Germans or Russians or French or English as monsters. He recognizes his kinship not

merely in body, but also in spirit to all of them, and he is able to understand and appreciate and in a measure to sympathize with all men. Hate and distrust are born of ignorance; knowledge brings sympathy. "To know all is to pardon all." Only a broader knowledge of and sympathy with our fellow men can end class and race antagonisms and guarantee a lasting peace. The study of biology, in broadening the sympathies of men and in cultivating esthetic appreciation, occupies a unique place among all the sciences.

These elements of personal culture are not absolutely distinctive of the biologist. Some persons wander into biology whose inherited tendencies are too strong to be overcome by its discipline; some good men in other fields are biologists gone astray; but in general these qualities are characteristic of the biologist.

II. CONTRIBUTIONS OF BIOLOGY TO CIVILIZATION

1. First among all the contributions of science to civilization stands the emancipation of man from various forms of bondage. Science has to a large extent freed civilized man from slavery to environment; it has well-nigh annihilated time and space, it has levied tribute upon practically the whole earth to supply his wants, it has taught him how to utilize the great resources of nature and to a large extent it has given into his hands the control of his destiny on this planet.

In this conquest of nature all sciences have been represented and it is difficult to apportion exactly the credit due to each. This is well illustrated by the various claims which are being made at present as to who built the Panama Canal. It is claimed by Colonel Roosevelt, by the army and navy, by the engineers, by the doctors and sanitarians, and one ought not to forget the workmen from the United States and the

Jamaica negroes, though they are saying little about it. That biologists can put in a strong claim can not be doubted when we reflect upon the former French attempt to build the canal and the ravages of malaria and yellow fever which helped to defeat that enterprise. I suggest as a topic for a general debate at the meetings of the American Association for the Advancement of Science at the Panama-Pacific Exposition next summer this question, "Who built the Panama Canal?" I am sure that biology will be able to show that it is entitled to a large share of the credit.

The contributions of biology to civilization are not generally regarded as equal to those of physics, chemistry or engineering, and yet they are many and great and are constantly increasing in importance. Indeed, the debt of civilization to biology is absolutely incalculable, as may be appreciated when one mentions merely the names of some of the biological sciences, as for example, agriculture, animal breeding, bacteriology, experimental medicine, pathology, parasitology, physiology, sanitation. All of the great advances in these fields in recent years are the results of the study of living things, whether that study was done in a biological laboratory or not, and they are therefore the contributions of biology to culture. Indeed, the very continuance of civilization depends upon biology; there were civilizations of the past which went down under the onslaughts of pestilence and famine, as well as of war, and if our civilization is to advance it must rely upon biology to teach improved methods of warding off disease, of increasing and conserving the food supply and of improving the human breed.

2. But the highest service of science to culture has been in the emancipation of the mind, in freeing men from the bondage of superstition and ignorance, in helping man

to know himself. The message of science to mankind has ever been the message of intellectual enlightenment and liberty, "Ye shall know the truth and the truth shall make you free."

The greatest contribution of biology to intellectual emancipation has been the doctrine of evolution, that great theory which has revolutionized all our thinking regarding man and nature. And evolution is the distinctive contribution of biology to civilization, for it was in the living world and especially in the human realm that the doctrine of evolution came as the great emancipator from superstition and ignorance. The greatest theme of evolution is not the origin of species, nor even the origin of living things, but rather the oneness of all life. This is indeed the greatest principle of biology, namely, that through all the endless diversity of the living world there runs this fundamental similarity and unity. We also are living things and all that concerns other forms of life is of direct interest to us. In the lower organisms we see ourselves in simpler and more primitive form; we see man from the standpoint of the whole living world, as superior beings in another planet might look upon us, and as a result we have ceased to a large extent to regard the universe as existing merely for us. In this intellectual revolution we have ceased to occupy a position of solitary grandeur in a little human universe; we have not grown less, but nature has become so much greater that man's relative position in nature has changed.

Contrast the old view of creation, that the universe was made in six literal days, with the revelations of science as to the immensity and eternity of natural processes. Contrast the old view that all organisms arose suddenly by divine fiat with the view that animals and plants and the world itself are the result of an immensely long

process of evolution. Contrast the old anthropocentric view of nature and of man with the new biocentric view which evolution has revealed; the old notion that man was absolutely distinct from all other creatures with the new conception of the oneness of life. As Darwin so beautifully says,

There is grandeur in this view of life with its several powers having been breathed by the Creator into a few forms or into one, and that whilst this planet has gone cycling on according to the first law of gravity from so simple a beginning endless forms most beautiful and most wonderful have been and are being evolved.

Biology has changed our whole point of view as to nature and man and has thus contributed more than any other science to the intellectual emancipation of mankind.

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THE VALUE OF SCIENTIFIC GENEALOGY

FROM out of the middle ages when learning was treasured by encloistered scholastics has come the tradition that science is necessarily esoteric; and that pure science has little or nothing to do with human affairs; and thus is to be contrasted sharply with the humanities. During the past half century anthropology, social as well as physical psychology and psychiatry, and medicine have developed into well-recognized sciences proceeding by methods as objective and experimental as physics or chemistry and contributing to our knowledge of the field lying between the sciences of biology and chemistry; and of behavior and morphology. To-day the man of science is quite willing not only to apply to the human species the laws that have been determined by the study of other organisms, but he is recognizing that man himself is as good material to use in getting at scientific principles as any other species; and that in certain subjects man affords the *best* mate-